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Investigation and Development of the Osseous Part of BoneWelding® Hybrid Implants

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INTRODUCTION: To enhance the stability of the bone-implant interface, a new process, the BoneWelding® Technology, has been developed during the recent years by WoodWelding AG offering new alternatives in the treatment of fractures and other degenerative disorders of the muskuloskeletal system[1,2]. The BoneWelding® process employs ultrasonic energy to liquefy a thermoplastic interface between orthopaedic implants and the host bone. The BoneWelding® process is compatible with many thermoplastics, including current resorbable orthopaedic polymers. Significant potential is seen in so called hybrid concepts, wherein the polymer is applied on the load bearing implant as a complete coating. This concept allows the combination of the load transfer characteristics of the polymer-bone interface with the high mechanical properties of metallic or ceramic core material. The aim of this project was to investigate and develop the osseous part of such a novel hybrid implant with titanium core and resorbable polymer coating (see Figure 1).

METHODS: Preliminary design and feasibility studies were performed, using aluminium and polycarbonate as substitute material for titanium and the resorbable polymer (PLDLLA 70/30). A specially designed bone model for normal and osteoporotic bone, consisting of aluminium foams, epoxy plates as cortical bone model and bone marrow substitute was used for evaluating the implant designs before implanting the actual titanium-resomer-hybrids into bone (bovine proximal tibiae). Thermal analysis, along with pullout and bending tests were performed to evaluate the final implant performance and to compare the found design to commercially available Schanz- and Pedicle screws. Furthermore, different hybrid designs, as well as classic pedicle screws, were evaluated in a FEM study.

RESULTS: It could be shown that a homogenous infiltration of the polymer along the implant can be achieved and that infiltration depth can be controlled by the thickness of the polymer coating. In respect to the density of each bone sample, the hybrid implant showed a good performance in comparison with Schanz- and Pedicle screws. In osteoporotic bone model, the hybrid implant showed a significant higher performance due to the strong microinfiltration interphase between the polymer and the trabeculae (see Figure 2).

Fig. 1: Hybrid implant with titanium core and PLDLLA coating

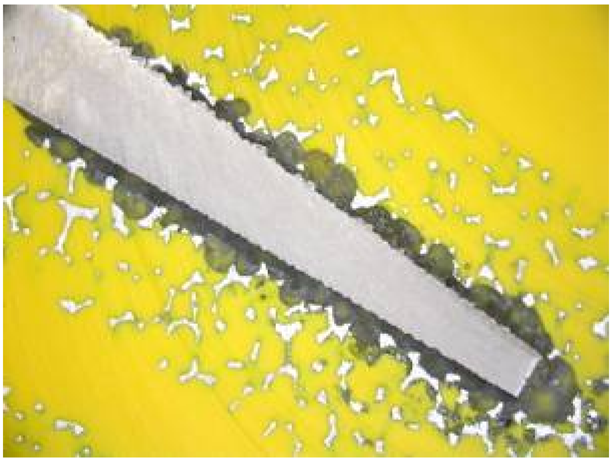

Fig. 2: Hybrid implant inserted into low densitiy aluminium foam (substitute material for osteoporotic bone)

DISCUSSION & CONCLUSIONS: The obtained results show a very promising potential of the developed hybrid implants, especially when applied in osteoporotic bone.

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